Technical note

THE SUGAR-POTASSIUM NEXUS WITHIN THE GRAPE BERRY

Introduction
Sugar accumulation into the grape berry accelerates with the onset of ripening and many macronutrients also accrue more rapidly. This research characterises the potential functional link between berry sugar and potassium (K⁺) accumulation. Potassium may have a role in the long distance transport of sugars along the vascular system and may thus facilitate the accumulation of sugar into the grape berry. Potassium also has an osmoregulatory function and may facilitate the ingress of water to drive berry growth. Berry K⁺, sugar (glucose and fructose) and water content were assessed during ripening in the skin, pulp and seeds under different photosynthetic and K⁺ fertilisation regimes. The expression of ten different transporters related to these three components was also characterised. While sugar transporters in relation to phloem unloading have received some attention in grapevines, the study of K⁺ transporters is still in its infancy.

The key outcomes
This study was novel in that the sugar-K⁺ relationship was, for the first time, illustrated in individual grape berries and in the grape berry tissues. Potassium and sugar accumulation were closely correlated in the berry pulp, skin and seeds, especially from véraison onwards. However, the sugar content increased more rapidly than K⁺ with a ten-fold difference observed at harvest. There was also extensive plasticity from berry to berry in the ratio between the two components. A strong ternary relationship between berry K⁺, sugar and water content was also evident. The closely correlated expression patterns of berry sugar, K⁺ and water transport proteins further supports the functional link between these three parameters.
Recommendations
Given that K⁺ is integral to normal berry development and because of its close links with water and sugar accumulation during ripening it is clear that K⁺ deficiency should be avoided. While many Australian soils are naturally high in K⁺, deficiency can occur through leaching or crop removal. The availability of K⁺ can also be limited in sandy soils, heavy clays and acid soils. Potassium can be applied as potassium chloride (in low saline soils), potassium nitrate or potassium sulphate. Mulches and composts may provide an additional source of K⁺ to the vineyard. Care is needed to satisfy the K⁺ requirements of grapevines without excess, given that excess can lead to high pH in grape juice and wine and negative effects on wine quality. Soil and petiole testing will give a good indication of additional requirements to be rendered through fertilisation.

What’s next?
Proposing a mechanism for sugar and potassium co-loading into the grape berry pericarp cells will be the first step towards revealing the underlying basis of the relationship.

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References

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